Marion Meteorological Tower Wind Monitoring

This document provides information not repeated in the monthly wind monitoring updates.

Instrumentation and Equipment

Wind monitoring equipment is mounted on the meteorological tower at Marion: Great Hill Dairy. A wind vane and two anemometers are located at two heights on the tower: 50 m and 38 m. Details of the equipment and models are:

- NRG model Symphonie Cellogger
- 4 – #40 Anemometers, standard calibration (Slope - 0.765 m/s, Offset – 0.380 m/s)
- 2 - #200P Wind direction vanes
- NRG 110S temperature Sensor

The data from the Symphonie logger is retrieved on a regular basis. The logger samples wind speed and direction once every two seconds. These are then combined into 10-minute averages, and along with the standard deviation for those 10-minute periods, are put into a binary file. These binary files are converted to ASCII text files using the NRG software BaseStation®. These text files are then imported into a database software program where they are subjected to QA tests prior to using the data.

Test Definitions

All raw data were subjected to a series of validation tests, as described below. The sensors tested are given below. Data which were flagged as invalid were not included in the statistics presented in this report.

MinMax Test: All sensors are expected to report data values within a range specified by the sensor and logger manufacturers. If a value falls outside this range, it is flagged as invalid. A data value from the sensor listed in Test Field 1 (TF1) is flagged if it is less than Factor 1 (F1) or greater than Factor 2. This test has been applied to the following sensors (as applicable): wind speed, wind speed standard deviation, wind direction, temperature, and solar insolation.

$$F1 > TF1 > F2$$

MinMaxT Test: This is a MinMax test for wind direction standard deviation with different ranges applied for high and low wind speeds. A wind direction standard

deviation data value (TF1) is flagged either if it is less than Factor 1, if the wind speed (TF2) is less than Factor 4 and the wind direction standard deviation is greater than Factor 2, or if the wind speed is greater than or equal to Factor 4 and the wind direction standard deviation is greater than Factor 3.

$$(TF1 < F1)$$
$$\text{or } (TF2 < F4 \text{ and } TF1 > F2)$$
$$\text{or } (TF2 \geq F4 \text{ and } TF1 > F3)$$

Icing Test: An icing event occurs when ice collects on a sensor and degrades its performance. Icing events are characterized by the simultaneous measurements of near-zero standard deviation of wind direction, non-zero wind speed, and near- or below-freezing temperatures. Wind speed, wind speed standard deviation, wind direction, and wind direction standard deviation data values are flagged if the wind direction standard deviation (CF1) is less than or equal to Factor 1 (F1), the wind speed (TF1) is greater than Factor 2 (F2), and the temperature (CF2) is less than Factor 3 (F3). To exit an icing event, the wind direction standard deviation must be greater than Factor 4.

$$CF1 \leq F1 \text{ and } TF1 > F2 \text{ and } CF2 < F3$$

CompareSensors Test: Where primary and redundant sensors are used, it is possible to determine when one of the sensors is not performing properly. For anemometers, poor performance is characterized by low data values. Therefore, if one sensor of the pair reports values significantly below the other, the low values are flagged. At low wind speeds (Test Fields 1 and 2 less than or equal to Factor 3) wind speed data are flagged if the absolute difference between the two wind speeds is greater than Factor 1. At high wind speeds (Test Fields 1 or 2 greater than Factor 3) wind speed data are flagged if the absolute value of the ratio of the two wind speeds is greater is greater than Factor 2.

$$[\ TF1 \leq F3 \text{ and } TF2 \leq F3 \text{ and } \text{abs}(TF1 - TF2) > F1\ ]$$
$$\text{or}$$
$$[(TF1 > F3 \text{ or } TF2 > F3) \text{ and } (\text{abs}(1 - TF1 / TF2) > F2 \text{ or } \text{abs}(1 - TF2 / TF1) > F2)]$$

Table1 : Test Definitions

TestOrder	TestField1	TestField2	TestField3	CalcField1	CalcField2	CalcField3	TestType	Factor1	Factor2	Factor3	Factor4
1							TimeTest Insert	0	0	0	0
4	Etmp2adegc						MinMax	-30	60	0	0
5	EtmpSD2adegc						MinMax	-30	60	0	0
10	Anem50ams						MinMax	0	90	0	0
11	Anem50bms						MinMax	0	90	0	0
12	Anem38ams						MinMax	0	90	0	0
13	Anem38bms						MinMax	0	90	0	0
20	AnemSD50ams						MinMax	0	4	0	0
21	AnemSD50bms						MinMax	0	4	0	0
22	AnemSD38ams						MinMax	0	4	0	0
23	AnemSD38bms						MinMax	0	4	0	0
30	Vane50adeg						MinMax	0	389.9	0	0
31	Vane38adeg						MinMax	0	389.9	0	0
50	Turb50zNONE						MinMax	0	2	0	0
51	Turb38zNONE						MinMax	0	2	0	0
60	Wshr0zNONE						MinMax	-100	100	0	0
70	Pwrd50zWMS						MinMax	0	5000	0	0
71	Pwrd38zWMS						MinMax	0	5000	0	0
200	VaneSD50adeg	Anem50yms					MinMaxT	0	100	100	10
201	VaneSD38adeg	Anem38yms					MinMaxT	0	100	100	10
300	Anem50ams	AnemSD50ams	Vane50adeg	VaneSD50adeg	Etmp2adegc		Icing	0.5	1	2	10
301	Anem50bms	AnemSD50bms	Vane50adeg	VaneSD50adeg	Etmp2adegc		Icing	0.5	1	2	10
302	Anem38ams	AnemSD38ams	Vane38adeg	VaneSD38adeg	Etmp2adegc		Icing	0.5	1	2	10
303	Anem38bms	AnemSD38bms	Vane38adeg	VaneSD38adeg	Etmp2adegc		Icing	0.5	1	2	10
400	Anem50ams	Anem50bms					CompareSensors	1	0.25	3	0
401	Anem38ams	Anem38bms					CompareSensors	1	0.25	3	0